

N3B-401

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98105

College of Engineering
Department of Aeronautics and Astronautics

October 18, 1965

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OFFICE OF GRANTS &
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Grants and Research Contracts Division
Office of Space Science and Applications
National Aeronautics and Space Administration
Washington, D. C. 20546

Subject: Semi-Annual Status Report for the Period April 1, 1965
through October 1, 1965, on Grant N3G-401/48-002-003

Gentlemen:

The project consists of an analytical and experimental study to establish a procedure, similar to photoelasticity, for stress analysis of a viscoelastic model subject to transient temperature and time-dependent loadings. The analytical basis for the interpretation of photoviscoelastic analysis in the linear range, together with details of the experimental procedure and example problems, is contained in the attached report. (Additional copies are being sent under separate cover.) We request that it be considered for publication by NASA as a low number Contract Report. Study is continuing on the following problems.

Plane Stress. Further experiments on the heated disk with external pressure are being performed. At the same time, numerical analysis is being made by the stiffness method. The experimental and analytical solutions to the problem can then be compared.

Imbedded Polariscopes. The standard imbedded polariscopes methods cannot be used for the birefringent viscoelastic model because of the stiffening effect of the polariser on the low modulus material. A procedure is being developed where the polaroid is chopped into small squares: A three dimensional model is sliced apart along two parallel planes, the squares of the polaroid are applied to the planes, and the model is bonded together again. If the method can be perfected, we will be able to study three dimensional problems.

Dynamic Testing. All of the experiments to date have been quasi-static, but we are now proceeding to develop methods for dynamic problems, including wave propagation. The first step is a characterization of the material. By using an electromagnetic shaker to drive a tension test specimen, we have been able to test up to 400 cycles per second. Other methods will be developed or adopted to permit complete dynamic characterization.

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Non-linear Problems. There are fundamental questions about the behavior of polymers at large strain which have not been answered. An analytical study of this problem is in progress. We expect to apply this study to the solution of large strain problems for viscoelastic materials, and to the interpretation of the methods of solution of plasticity problems by photomechanics which have been proposed.

A more detailed report of the progress in each of these areas should be available for the next status report.

Sincerely yours,



R. J. H. Bollard, Professor



E. H. Dill, Professor

Principal Investigators

EHD:pw

Attachments: Project Publications
Report 65-1

PROJECT PUBLICATIONS

1. "Photothermoviscoelasticity" by E. H. Dill, Trend in Engineering, University of Washington publication, Vol. 14, No. 4, October 1962.
2. On the Theory of Photoviscoelasticity by E. H. Dill, Department of Aeronautics and Astronautics, Report 63-1, University of Washington, January 1963.
3. "On the Phenomenological, Rheo-Optic Constitutive Relations" by E. H. Dill, Journal Polymer Science, Part C, Polymer Symposia, 1964, p. 67.
4. "A Theory of Photothermoviscoelasticity" by E. H. Dill, Transactions 4th International Congress on Rheology, 1963.
5. "Photoviscoelastic Experiments, I" by E. H. Dill and C. W. Fowlkes, Trend in Engineering, University of Washington publication, Vol. 16, No. 3, July 1964.
6. "Photoviscoelasticity" by E. H. Dill, Proceedings of the International Conference on the Mechanics and Chemistry of Solid Propellants, Purdue University, 1965.
7. Photoviscoelasticity by E. H. Dill and C. W. Fowlkes, Department of Aeronautics and Astronautics, Report 65-1, University of Washington, September 1965.

PAPERS PRESENTED

1. "The Theoretical Basis of Photoviscoelasticity" presented at the Symposium on Optical Properties of High Polymers, California Institute of Technology, April 3, 1963.
2. "On Phenomenological Rheo-Optic Constitutive Relations" presented at the Symposium on Rheo-Optical Properties of High Polymers, University of Massachusetts, August 1963.
3. "Photothermoviscoelasticity - Application to Grain Integrity Studies" presented at the AIAA Sixth Solid Propellant Rocket Conference, Washington, D.C., February 1965.
4. "Photoviscoelasticity" presented at the International Conference on the Mechanics and Chemistry of Solid Propellants, Purdue University, April 1965.

PROJECT REPORT

1. Photothermoviscoelasticity by E. H. Dill and R. J. H. Bollard, Department of Aeronautics and Astronautics, University of Washington, July 1965.

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